

ONS00507  
10/797,537

Amendments to the Drawings

Applicants are submitting formal drawings for this application to the Patent & Trademark Office under a separate cover letter. Applicants are including copies of the submitted formal drawings hereto labeled as "Replacement Sheets" in view of the following changes made to the originally filed informal drawings:

1. Element number 14 denoting the major surface as described, for example, in paragraphs [0013], [0017], and [0019] has been added to FIGS. 1-3.
2. Element number 46 denoting the gate structure as described, for example, in paragraph [0022] has been corrected in FIGS. 1 and 3.
3. Element number 49 denoting a surface gate portion as described, for example, in paragraphs [0022] and [0026] has been corrected in FIGS. 1 and 3.
3. Element number 47 denoting a trench gate portion as described, for example, in paragraphs [0022]-[0025] has been corrected in FIGS. 1-3.

ONS00507  
10/797,537REMARKS

Claims 1-6 and 8-21 are in the application. Claim 7 has been cancelled without prejudice as to the subject matter claimed.

By this amendment, claims 1, 4, 5, 9, 10, 11, 12, and 17 have been amended to more particularly set-out and claim applicants' invention. FIG. 1 and paragraphs [0016] and [0021] support the changes to claim 1. FIG. 1 and paragraph [0017] support the changes to claims 9 and 11. FIGS. 1 and 3 and paragraphs [0022] and [0026] support the changes to claims 5 and 10. FIG. 3 and paragraph [0033] support the changes to claims 4, 12 and 17. Additionally, claim 8 has been amended to properly depend from claim 1 in view of the changes made to claim 1 and the cancellation of claim 7.

Claim 21 has been added by this amendment. FIGS. 1 and 3 and paragraphs [0016], [0017], [0022], and [0026] support the addition of new claim 21.

In addition, applicants have amended paragraphs [0028] and [0029] to correct several typographical errors. FIG. 1 supports the correction to paragraph [0028], and paragraph [0022] supports the corrections to paragraph [0029].

Moreover, applicants have submitted formal drawings to the Patent & Trademark Office under a separate cover letter. Copies of the submitted formal drawings are attached hereto. The changes incorporated into the formal drawings are noted on page 9 of this amendment together with supporting references to the specification.

Objection to the Drawings

In the present Office Action, applicants' informal drawings were objected to in view of missing element

ONS00507  
10/797,537

numbers. Applicants have submitted corrected formal drawings in compliance with 37 CFR 1.121(d), and respectfully believe that this objection has been overcome.

Responses to Claim Rejections

Claims 1-3, 5-9, 10, 11, 13-15, 17, 18, and 20 were rejected under 35 U.S.C. §102(b) over Tihanyi, U.S. Patent No. 6,507,071 (hereafter "Tihanyi"). Applicants note that the rejection to claim 7 is now moot in view of its cancellation. Applicants respectfully traverse the rejection of claims 1-3, 5-6, and 8-9 in view of the amendments made herein and the arguments presented hereinafter.

Tihanyi teaches a lateral high-voltage sidewall transistor in which alternating semiconductor layers of one conductivity type and of another conductivity type are provided over a low-doped semiconductor substrate of the other conductivity type. Tihanyi's source regions 10 and drain regions 9 each extend through the semiconductor layers as far as the semiconductor substrate 1. Also, Tihanyi's body regions 11 extend as far as the semiconductor substrate 1 and extend partially under the gate electrode (see Col. 1, line 62 through Col. 2 line 12). Additionally, Tihanyi shows a gate insulative material 12 and a gate electrode material 14 only along sidewalls of the gate trench, and neither layer extends over or overlies the major surface of the structure.

Claim 1 calls for a lateral IGFET device comprising a semiconductor substrate having a first conductivity type. A region of semiconductor material comprising alternating layers of first and second conductivity type material is formed overlying the semiconductor substrate and

ONS00507  
10/797,537

has a first major surface, the region of semiconductor material further includes a top layer of the first conductivity type formed adjacent the first major surface and one of the alternating layers of the second conductivity type formed adjacent and below the top layer. A drain region of the second conductivity type extends from the first major surface into at least a portion of the region of semiconductor material. A body region of the first conductivity type is formed in a portion of the region of semiconductor material and extending from the first major surface partially into the top layer. A first source region is formed in the body region, and a trench gate structure is formed in a portion of the region of semiconductor material and adjoining the alternating layers, wherein the trench gate structure controls a sub-surface channel region.

Applicants respectfully submit that Tihanyi does not show a body region of the first conductivity type formed in a portion of the region of semiconductor material and extending from the first major surface partially into the top layer. As stated above, Tihanyi's body regions 11 extend as far as the semiconductor substrate 1, and do not terminate within the top layer as claimed. Thus, applicants respectfully submit that claim 1 is allowable over Tihanyi for at least this reason.

Claims 2 and 3 depend from claim 1 and are believed allowable for at least the same reason as claim 1.

Claim 5 depends from claim 1 and further calls for a surface gate structure including a gate dielectric layer formed overlying the first major surface and a gate electrode layer overlying the gate dielectric layer, wherein the surface gate structure controls conduction in a surface channel region. Claim 5 is believed allowable for the same

ONS00507  
10/797,537

reasons as claim 1. Additionally, applicants respectfully submit that Tihanyi fails to show a surface gate structure including a gate dielectric layer overlying the first major surface and a gate electrode layer overlying the gate dielectric layer. As stated above, Tihanyi only shows a gate dielectric layer lining the sidewalls of the trench (see Col. 1 lines 46-47; and FIG. 2).

Claims 6 and 8 depend from claim 1 and are believed allowable for at least the same reason as claim 1.

Claim 9 depends from claim 5 and further calls for a diffused drain extension region of the second conductivity type formed in the top layer and between the body region and the drain region. Claim 9 is believed allowable for the same reasons as claims 1 and 5. Additionally, applicants respectfully submit that claim 9 is allowable because Tihanyi does not show a diffused drain extension region of a second conductivity type formed in the top layer between the body region and drain region.

Claim 10 calls for a lateral MOSFET device comprising a semiconductor substrate and a region of semiconductor material including a plurality of alternating layers of first and second conductivity semiconductor material formed over the semiconductor substrate and having a major surface. A trench drain structure is formed in the region of semiconductor material. A trench gate structure is formed in the region of semiconductor material, and a surface gate structure including a gate dielectric layer and a gate conductive portion is formed overlying the major surface. A body region of first conductivity type is formed adjacent the trench gate structure and the surface gate structure, and a source region of the second conductivity type is formed in the body region.

ONS00507  
10/797,537

Applicants respectfully submit that Tihanyi fails to anticipate claim 10 because as stated above, Tihanyi does not show a surface gate structure including a gate dielectric layer and a gate conductive portion formed overlying the major surface. In Tihanyi, the gate insulating layer and the gate conductive layer only line the trench sidewalls. Thus, applicants respectfully submit that claim 10 is allowable over Tihanyi for at least this reason.

Claim 11 depends from claim 10 and further calls for a diffused drain extension region of the second conductivity type formed in a portion of the region of semiconductor material and extending from the major surface, and a region of the first conductivity type formed within a portion of the diffused drain extension region. Applicants respectfully submit that claim 11 is allowable for at least the same reasons as claim 10. Additionally, applicants submit that claim 11 is allowable over Tihanyi because Tihanyi does not show a diffused drain extension region of the second conductivity type formed in a portion of the region of semiconductor material and extending from the major surface. Moreover, Tihanyi does not show a region of the first conductivity type formed within a portion of the diffused drain extension region.

Claims 13-15 depend from claim 10 and are believed allowable for at least the same reasons as claim 10.

Claim 17 calls for an insulated gate FET structure comprises alternating layers of first and second conductivity type material forming a semiconductor region. A trench gate structure is formed in the alternating layers, wherein the trench gate structure controls a sub-surface channel region. A body region of the first conductivity type is formed in the semiconductor region adjacent the

ONS00507  
10/797,537

trench gate structure. A drain region of the second conductivity is formed in the semiconductor region and spaced apart from the trench gate structure and extending into the alternating layers. A source region of the second conductivity type is formed in the body region and adjacent to the trench gate structure. A doped region of the second conductivity type is formed along a sidewall of the trench gate structure and extending into the semiconductor region below the body region and adjacent the alternating layers.

Applicants respectively submit that claim 17 is allowable over Tihanyi because Tihanyi does not show a doped region of the second conductivity type formed along a sidewall of the trench gate structure and extending into the semiconductor below the body region. In addition, applicants respectfully submit that Disney, U.S. Patent No. 6,509,220 does not show such a structure. In particular, region 41 in Disney referenced in the present Office Action is the opposite conductivity type to that called for in the doped region of claim 17, and region 41 does not extend below the body region 40 nor is it adjacent the alternating layers as is further called for in claim 17. Moreover, the Office Action states that region 41 is formed to increase the integrity of the source-to-substrate connection and to reduce susceptibility of the device to bipolar effects. However, as claimed applicants doped region reduces on-resistance (see applicants' specification at paragraph [0033], which is a completely different effect than that described by the Examiner. Thus, applicants respectfully submit that claim 17 allowable over both Tihanyi and Disney.

Claims 18 and 20 depend from claim 17 and are believed allowable for at least the same reasons as claim 17.

ONS00507  
10/797,537

New claim 21 depends from claim 17 and further calls for a top layer of the second conductivity formed over one of the alternating layers of the first conductivity type to form an upper major surface of the semiconductor region, wherein the top layer is thicker than the alternating layers of first and second conductivity type. Also, an extended drain region of the second conductivity type is formed in a portion of the top layer and extending partially into the top layer from the upper major surface, and a surface gate portion including a gate dielectric layer overlying the upper major surface of the semiconductor region and a gate conductive portion overlying the gate dielectric portion, wherein the surface gate portion controls a channel for conducting current in proximity to the upper major surface.

Claim 21 is believed allowable for the same reasons as claim 17. Additionally, applicants respectfully submit that both Tihanyi and Disney fail to show a surface gate in combination with a trench gate as claimed. Specifically, applicants point out that FIG. 4 of Disney shows a surface gate with a trench isolation 62, FIG. 5 of Disney shows a trench gate alone, and FIG. 6 of Disney shows a surface gate alone. In addition, neither reference shows a diffused drain extension region in the top layer as called for in claim 21. Thus, claim 21 is believed allowable for these additional reasons.

Claims 4, 12, 16, and 19 were rejected under 35 U.S.C. §103(a) as being unpatentable over Tihanyi in view of Disney. This rejection is respectfully traversed in view the amendments made herein and the remarks presented hereinafter.

Claim 4 depends from claim 3 and further calls for a first doped region of the second conductivity type formed adjacent a portion of the sidewall surfaces and adjacent the



ONS00507  
10/797,537

alternating layers. Applicants respectfully submit that Disney does not make up for the deficiencies of Tihanyi, and thus, claim 4 is believed allowable for the same reasons as claims 1 and 3. In addition, neither reference shows or suggests a first doped region of the second conductivity type formed adjacent a portion of the sidewall surfaces of the trench gate nor adjacent the alternating layers. In particular, region 41 in Disney referenced in the present Office Action is the opposite conductivity type to that called for in the doped region of claim 4, and region 41 is not adjacent the alternating layers as called for in claim 4. Thus, applicants respectfully submit that claim 4 allowable over both Tihanyi and Disney.

Claim 12 depends from claim 10 and further calls for a doped region of the second conductivity type formed in the region of semiconductor material adjacent a portion of the trench gate structure and below the body region. Applicants respectfully submit that Disney does not make up for the deficiencies of Tihanyi, and thus, claim 12 is believed allowable for the same reasons as claims 10. In addition, neither reference shows or suggests a doped region of the second conductivity type formed in the region of semiconductor material adjacent a portion of the trench gate structure and below the body region. In particular, region 41 in Disney referenced in the present Office Action is the opposite conductivity type to that called for in the doped region of claim 12, and region 41 does not extend below the body region 40 as is further called for in claim 12. Thus, applicants respectfully submit that claim 12 allowable over both Tihanyi and Disney.

Claim 16 depends from claim 10 and further calls for the trench gate structure to extend further into the region

ONS00507  
10/797,537

of semiconductor material than the trench drain structure. In Tihanyi, the trench gate and the trench drain are at the same depth as evident in FIG. 2. In Disney, there is no structure with both a trench gate and a trench drain as called for in claim 16. In the rejection of similar claim 19, the Office Action refers to Disney's FIGS. 4 and 5 as evidence of this element. However, FIG. 4 shows a diffused drain 47, and no trench gate at all. In FIG. 5, Disney does show a trench gate, but the drain is diffused as in FIG. 4. Thus, applicants respectfully submit that claim 16 is allowable over Tihanyi and Disney for these additional reasons.

Claim 19 depends from claim 18 and further calls for the trench gate structure to extend into the alternating layers deeper than the drain region, which comprises a trench filled with a polycrystalline semiconductor material. Claim 19 is believed allowable for the same reasons as claims 17 and 18. Additionally, in Tihanyi, the trench gate and the trench drain are at the same depth as evident in FIG. 2. In Disney, there is no structure with both a trench gate and a trench drain as called for in claim 19. In the rejection of claim 19, the Office Action refers to Disney's FIGS. 4 and 5 as evidence of this element. However, FIG. 4 shows a diffused drain 47, and no trench gate at all. In FIG. 5, Disney does show a trench gate, but the drain is diffused as in FIG. 4. Thus, applicants respectfully submit that claim 19 is allowable over Tihanyi and Disney for these additional reasons.

In view of all of the above, it is believed that the claims are allowable, and the case is now in condition for allowance, which action is earnestly solicited.

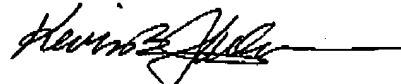
ONS00507  
10/797,537

With the cancellation of claim 7, applicants respectfully believe there is no amount due for new claim 21. However, the Commissioner is hereby authorized to charge any amount due or credit any overpayment to Deposit Account 501086.

In addition, if there are any remaining matters that can be resolved by telephone conference, applicants' undersigned attorney invites Examiner Rose to contact him at her convenience at 602.244.4885.

Respectfully submitted,

Rajesh S. Nair et al.



Kevin B. Jackson  
Attorney for Applicant  
Reg. No. 38,502  
Tel. (602) 244-4885

ON Semiconductor  
Intellectual Property Dept.  
P.O. Box 62890; M/D A700  
Phoenix, AZ 85082-2890

Date: September 7, 2005